Again, as suggestive of prejudice, we must take the strongest exception to the author's use of the expression "than might have been anticipated" in connection with the affinities between pterodactyles and dinosaurs. What right had anybody to form "anticipations"?

If the author really intends to imply that birds and pterodactyles are divergent and specialised branches from groups of reptiles which cannot yet be identified (at all events in the latter case) with any approach to certainty, we can agree with him. But this by no means implies any intimate relationship between the two branches in question, the structure of the limbs of which is alone amply sufficient, in our opinion, to demonstrate their totally different origin. In urging an affinity between birds and pterodactyles, Prof. Seeley, in addition to the (may we say superficial?) resemblances between their skulls and brains, lays stress on the fact that both have pneumatic bones. This feature is taken as an indication that pterodactyles probably possessed warm blood, from which is drawn the further inference that they were also furnished with a four-chambered heart. Even if the first inference be well founded, the second by no means follows, the author himself quoting the fact that the blood of the tunny has a temperature of 90°. And even if pterodactyles were warm-blooded and furnished with an avian type of heart, we should be none the more inclined to admit their affinity with birds.

Apparently the author takes no account of similar modes of life leading to the development of superficially similar bodily structure in totally different groups of animals, and the consequent "convergent" resemblance between them. And if this be so, his premises are so widely different from those on which the investigations of others are based that it is little wonder irreconcilable diversity of view results.

An instance of this nature occurs on p. 219, where we find the statement that "a few characters of ornithosaurs are regarded as having been *acquired*, because they are not found in any other animals, or have been developed only in a portion of the group." In one sense all characters are acquired; but the use which the author makes of the term "acquired characters" does not correspond with its ordinary scientific acceptation. From this we may perhaps infer that in other instances the signification attached to terms is different from that usually in vogue—which would account for much.

It is not, however, solely in regard to the affinities of these reptiles, as we still take leave to call them, that the author differs so much from current views. He likewise attributes to pterodactyles a bodily form quite unlike that with which they are generally credited; and one, it may be said, which makes them the most grotesque and bizarre creatures that ever walked this earth. But could they walk at all, as thus restored? is a question which can scarcely fail to occur to those who look on these wonderful pictures. In most or all other restorations, as in the plate by Smit in Hutchinson's "Extinct Monsters," pterodactyles, when not flying, are shown crawling on rocks or cliffs, or sitting up on their hind legs on some prominence preparatory to taking flight. Prof. Seeley will, however, have nothing to say to such crouching attitudes, and represents the creatures standing on all fours, with the greatly elongated wing-finger bent back alongside the fore-arm and projecting above the hind-quarters, and the wing folded like an inverted Chinese sun-shade. Whether such slender hind-limbs as are shown in the restoration are capable of supporting the weight of the body in this position we will not pause to inquire. Our difficulty is in connection with the fore-limb, the raising of which would apparently cause the wings to strike against the ground at every step, even if they did not become entangled with the hind-legs. Moreover, the creature is represented as actually standing on the joint between the metacarpus and the wing-finger, and as this joint must certainly have been a highly delicate and complex structure, it appears impossible to conceive how it could have escaped injury in walking if carried in the position shown in the restoration. Possibly the author has an explanation of these difficulties, but if so it would have been more satisfactory had it been given to the public.

To revert, in conclusion, to the main argument of the book, we fully realise the amount of labour that Prof. Seeley has expended on a very difficult subject, and at the same time are prepared to admit the advantage which often accrues to the progress of science from the presentation of opinions widely different from those generally entertained. Nevertheless, we scarcely think that he will persuade those of his readers whose verdict is worth having to agree with him in regarding pterodactyles and birds as in any way near akin, or will convince them that the former creatures are no longer entitled to be classed as reptiles. Aberrant they are, no doubt, but not so much so as, in our opinion, to be excluded from the limits of a class comprehensive enough to embrace such diverse types as dinosaurs, turtles, ichthyosaurs and snakes. As to the alleged relationship between the "dragons of the air" and the egg-laying mammals, we are fain to confess that it requires a greater power of imagination to realise the nature of the affinity than it falls to our own lot to possess. R. L.

ELEMENTARY DYNAMICS.

Theoretical Mechanics: an Elementary Treatise. By W. Woolsey Johnson, Professor of Mathematics, U.S. Naval Academy. Pp. xv+434. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1901.) Price 3 dollars net.

THE author states in his preface that "the study of mechanics is here supposed to follow an adequate course in the differential and integral calculus." Hence it is difficult to see how it can appeal to any class of students—at least in this country—especially as, in addition to both branches of the calculus, the conceptions of geometry of three dimensions are also introduced at the outset. The student who has already progressed thus far in mathematics does not require to be introduced to the parallelogram of forces and all the elements of the composition and resolution of coplanar forces and velocities. There is nothing distinctively novel in the work, which is, on the whole, a careful compilation from the works of the best writers on the subject, without any acknowledgment of the sources.

The first two chapters deal with forces acting on a particle, and make free use of the calculus and geometry

of three dimensions. In chapter iii. the author settles down to the composition, resolution, and equilibrium of a general system of coplanar forces, and gives a very good exposition of the subject; but in this chapter, of nearly fifty pages, no use of either the calculus or three-dimensional geometry is made, except in three pages devoted to the common catenary. Now the understanding of this very important and extensive section of dynamics is well within the power of any student even if he is quite ignorant of these branches of pure mathematics, so that it seems a pity that he should be kept back in his dynamical studies until he has passed through "an adequate course in the differential and integral calculus."

Passing over chapters devoted to the determination of centres of gravity and the composition of forces which are not coplanar, we come to chapter vii., which treats of the principle of work. This chapter is somewhat meagre, consisting mainly of what is known as "book-work," and not containing sufficient illustration of the applications of the principle to concrete cases. Until the student comes to chapter viii. he will experience no difficulty in the author's treatment of the subject; but when he reaches this chapter, on "motion produced by constant force," he will find a good deal about the nature of "inertia regarded as a force" which will be very perplexing. His main difficulty will be to decide whether the author means the "force of inertia" to be one exerted *by* a body or *upon* it by some agent or medium. Thus, at the beginning of art. 288 it would appear to be a force exerted *by* the body:—

"The property of matter through which *it resists* any change of motion, in accordance with the First Law of Motion, is called Inertia."

But a few lines farther on we have the sentence:—

"Now, just as the resistance of a fixed body in contact with that upon which the force acts, and preventing its motion, is regarded as a force equal and opposite to the force which would otherwise produce motion, so the resistance to motion in the body when free is regarded as a force equal and opposite to the active force which produces the motion."

Let us suppose a particle M acted upon by forces whose resultant is P and kept from moving by the resistance, N, of a fixed surface B; then the force N is exactly equal and opposite to the force P. Again, imagine the body M acted upon by the same force P and unresisted by any fixed surface; M will have an acceleration a, and the statement is that there is acting on M a force resisting the acceleration a—this force being clearly produced by something which in our thoughts replaces the above fixed surface B—that this force is equal and opposite to "the active force which produces the motion." So far, what this "active force" is is not clear; but the next sentence defines it:—

"Thus the force of inertia acts upon a particle of mass m only when there is an acceleration a, and its value is ma, while its direction is opposite to that of the acceleration."

Now observe that if the particle had no acceleration, this force would be zero, while in the first part of the analogy (where also $a = 0$) the supposed analogous force, N (the resistance of the surface B) is not zero.

However, from this and from subsequent statements it is clear that, in the author's view, a force of inertia really acts on a particle m which has an acceleration a, and that this force is scalarly and vectorly equal to $-ma$; that is to say, it is D'Alembert's fictitious "reversed effective moving force." But this is not in accordance with the statement at the top of p. 288:—

"And the inertia which acts upwards is, at that point, simply the resistance of the body to being moved away from the tangent at O."

It is certainly strange that a force acting *on* a body should be the resistance of the body to being moved. The author, however, clearly defines his conception, which he calls that of "kinetic equilibrium," at the top of p. 244:—

"For example, suppose a man whose weight is W to be standing on the floor of an elevator which begins to descend with the known acceleration a. The forces acting on the man are his weight, $W=mg$, acting downward, his inertia, ma, acting upward because the acceleration is downward, and the resistance R of the floor of the elevator acting upward. Since the forces are all vertical, there is but one condition of equilibrium, namely, $W=R+ma$."

The objection which a student will raise to this is that if the man is really acted upon by the upward force ma, the man is really at rest and not in motion at all.

D'Alembert never attributed anything but a fictitious existence to his "reversed effective forces," and he was right and consistent all through. The real objection to his principle is that it teaches us to be dissatisfied with the actuality (viz. motion), and to seek refuge in a fiction (viz. rest). The teaching of Newton's second axiom is quite different: it accepts motion as a fact and deals with it.

The remainder of the book gives somewhat short and easily readable discussions of central orbits, motion (especially uniplanar) of rigid bodies, moments of inertia, and impulses.

OUR BOOK SHELF.

The Earliest Inhabitants of Abydos; a Craniological Study. By D. Randall-Maciver. Plates viii + tables 16. (Oxford: Clarendon Press, 1901.) Price 10*s.* 6*d.* net.

IN the present work Mr. Randall-Maciver presents to the public the craniological material which he obtained in Upper Egypt in the winter of 1899-1900, and the results which he has deduced from it. In a series of eight plates he gives us photographs of a large number of skulls which he obtained from two cemeteries at Abydos, which, he says, belonged to the earliest and the latest stages of the pre-dynastic period, and to these he adds some sixteen tables of minute craniological measurements. The first cemetery contained only pottery of the earliest forms, black-topped, polished red, and white ornamented red, and the second degraded wavy-handled vases and other pottery of well-defined classes. The remarks which Mr. Randall-Maciver makes in his short preface may be regarded as a continuation of those expressed in his "Libyan Notes," and we observe that he still holds the view that the theory of the Libyan origin of the pre-dynastic or proto-dynastic Egyptians is "based on wholly inadequate evidence." The pre-dynastic Egyptians were, he thinks, a mixed race, but as a whole that race was not Berber; on the other hand, he does not deny the existence of an original Berber substratum,